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State of Connecticut

REPORT

OF

The Connecticut Agricultural Experiment Station

FOR THE YEAR 1901

PART III

FIRST REPORT OF THE STATE ENTOMOLOGIST

W. E. BRITTON, B.S.

I.
E.

FIRST REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

FOR THE YEAR 1901

BY

W. E. BRITTON, B.S.

State Entomologist

New Haven, Conn.

1902

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FIRST REPORT

OF THE

STATE ENTOMOLOGIST OF CONNECTICUT

To the Board of Control of the Connecticut Agricultural Experiment Station:

I herewith transmit my first Report, as State Entomologist, covering the time from July 1st, 1901, when the law creating this office went into effect, to December 31st, 1901. Though this includes a period of only six months, it is desirable that such reports be made at the close rather than in the middle of a season's work. The results of certain experiments which were made before the passage of the Law Concerning Insect Pests, are contained herein, as it is advisable to include in one report all the entomological work of the season.

The account of receipts and expenditures covers only three months, July 1st to September 30th, 1901, in order to make the fiscal year in the future correspond with the State fiscal year.

Respectfully submitted,

W. E. BRITTON.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FOR THE PERIOD FROM JUNE 1ST, 1901, TO SEPTEMBER 30TH, 1901.

RECEIPTS.

Advanced by William H. Brewer, Treasurer	$550.00

EXPENDITURES.

Laboratory assistance	$150.00	
Printing	59.25	
Postage	21.95	
Stationery	5.35	
Telephone and Telegraph	1.05	
Express	.25	
Library	6.25	
Scientific apparatus and supplies	166.23	
Office supplies	3.72	
Traveling, nursery inspection	7.05	
Traveling, orchards, gardens, etc.	6.90	
	$428.00	
Balance on hand	122.00	
		$550.00

Memorandum—This account of the State Entomologist has been duly audited by the State Auditors of Public Accounts.

State Provision for Entomological Work.

The damage caused by the San José scale-insect has been the inciting cause of the enactment of laws, in more than half the states of the union, aiming to prevent the further spread of this and other pests. In some cases the laws aim only to control the pest by rigid inspections and by restricting the shipment of nursery stock. In others, provision is made for the investigation of the habits of insect pests of all kinds, and for testing remedies.

Since 1897, in the absence of any Connecticut laws requiring it, the Station had been called upon to inspect nurseries and to issue certificates where the circumstances warranted it; for without some such arrangement Connecticut nurserymen found themselves debarred from shipping stock into those states where inspection laws were in force.

This arrangement afforded no real protection to purchasers of nursery stock in Connecticut, as has been pointed out.* The rapid spread of the San José scale, and the increased interest in fruit growing in the State, made it evident that some means of protecting Connecticut fruit growers must be devised. The matter was discussed informally by the leading orchardists and nurserymen, who expressed a desire for legislation which would provide that the nurseries be kept clear of insect pests, and which would also assist the fruit growers by testing methods of destroying the San José scale, and by investigations concerning other insect pests.

At the annual meeting of the Connecticut Pomological Society at Hartford, February 7th, 1901, resolutions were adopted calling attention to the destruction caused by the San José scale, and recommending that a law be enacted to protect the fruit interests of the state from this dreaded pest. A bill was introduced into the legislature and thoroughly discussed at a hearing before the joint committee on Agriculture on March 19th. The discussion led to the drafting of a substitute bill which met the views of the fruit growers represented and of the committee. This was passed on June 4th and approved by the Governor on June 10th. The text of the law is given below:

*See Bulletin 135, p. 5, and Report of the Conn. Pomological Society for 1901, p. 107.

The Insect Pest Law.*

Chapter 122.

AN ACT

Concerning Insect Pests.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1. The board of control of the Connecticut Agricultural Experiment Station, at New Haven, shall designate and appoint a man qualified by scientific training and practical experience to be state entomologist during the pleasure of the board, and to be responsible to said board for the performance of his duties as prescribed in this act. The state entomologist shall have an office at the Experiment Station in New Haven, but shall receive no compensation other than his regular salary as a member of the station staff. He may appoint such number of deputies, not exceeding three, as he may deem necessary or expedient.

Sec. 2. It shall be the duty of the state entomologist, either personally or through his deputies, to visit any orchard, field, garden, nursery, or store-house, upon the request of the owner, to advise treatment against pests. He may inspect any orchard, field, or garden, in public or private grounds, which he may know or have reason to suspect is infested with San José scale or any other serious pests; may from time to time issue such circulars and bulletins as in his judgment are needed to convey information about pests, which publications may be issued as bulletins of the said experiment station; may also conduct such experiments and investigations regarding injurious insects as will tend toward a better understanding of them and the remedies for their attacks; may diffuse such information by means of correspondence, lectures, and published matter; and may employ such assistance in his office, laboratory, or in the field, and purchase such apparatus and supplies as he may deem necessary for the successful prosecution of his duties. He shall keep a detailed account of expenses and shall publish each year a report of such expenses, and of the work done under this act.

Sec. 3. All nursery stock shipped into the state from some other state, country, or province, shall bear on each box or

*The law was printed in Bulletin 134.

package a certificate that the contents of said box or package have been inspected by a state or government officer and that said contents appear to be free from all dangerous insects or diseases. In case nursery stock is brought within the state without such a certificate, the consignee may return it to the consignor at the latter's expense, or may call the state entomologist to inspect the same and deduct the costs of such inspection from the consignor's bill for such stock. This section shall be deemed to be a part of every contract made in this state for the sale of nursery stock to be shipped into this state.

SEC. 4. All nurseries or places in the state where nursery stock is grown, sold, or offered for sale, shall be inspected at least once a year by the state entomologist or one of his deputies, and if no serious pests are found, a certificate to that effect may be given. If such pests are found, the owner shall take such measures to suppress the same as the state entomologist shall prescribe. If such measures are not immediately taken by the owner of such nursery or place, such certificate shall be withheld, and any nurseryman who does not hold such a certificate after the first annual inspection as herein prescribed, who shall sell or otherwise dispose of nursery stock in the state, shall be fined not more than fifty dollars. The form of certificate as well as the season for inspecting nurseries may be determined by the state entomologist. The state entomologist or any of his deputies shall at all times have the right to enter any public or private grounds in the performance of any duty required by this act.

SEC. 5. The sum of three thousand dollars annually for two years is hereby appropriated for carrying out the provisions of this act, and the comptroller is hereby directed to draw his orders therefor quarterly on the treasurer in favor of the treasurer of the Connecticut Agricultural Experiment Station, who shall hold the same subject to the order of the state entomologist.

SEC. 6. This act shall take effect July 1, 1901.

Approved June 10, 1901.

SCOPE OF THE LAW.

A careful examination of the law shows that it was conceived in a broad spirit, and that it aims to provide for research and the diffusion of information which shall enable orchardists

and nurserymen to rid their own premises of insect pests, and to keep them clean, rather than to authorize any condemnation or destruction of private property by a state officer.

The law gives the state entomologist only advisory power; he cannot order the destruction of trees no matter how badly they are infested, and he has no police duties to perform.

It provides for the annual inspection of all nurseries in the state in order to keep them in the best possible condition. If found infested, the entomologist will advise the proper methods to destroy the pests, and if the owner refuses to comply, the certificate will not be granted.

After the first inspection every nurseryman is required by the law, Section 4, to have a certificate from the state entomologist before selling nursery stock within the state, under penalty of fifty dollars fine.

The law also requires that all nursery stock shipped into the state shall be accompanied by a certificate of inspection by a state or government officer. Failure to observe this rule should be reported in each case to the state entomologist.

The law provides for the dissemination of knowledge by means of publications, lectures, correspondence, etc., and the entomologist is expected to visit any orchard, nursery, storehouse, garden or field, when called upon to make an examination of conditions, and to advise treatment.

The state entomologist, and his deputies, are given the right to enter, at any time, any public or private grounds in the performance of their duties.

None of the appropriation provided for in this bill can be used to pay the salary of the state entomologist, but may be used to pay the salaries of deputies (not to exceed three in number) or for assistance in the field and laboratory as is deemed necessary. The entomologist's salary is paid by the experiment station.

Organization and Progress of the Work.

At a meeting of the board of control, held at the station on July 10th, 1901, the writer was appointed state entomologist. The office, laboratory, microscopes, and other apparatus previously used in this department, were placed at the disposal of the

entomologist for the new work. Though the law went into effect July 1st, the money appropriated for insect work was not available until the end of the first quarter, October 1st. The board of control authorized the treasurer of the station to advance money to the state entomologist so that the work could be immediately begun. An excellent photographic outfit was purchased and an expert photographer was employed for nearly six weeks to prepare illustrations of insects for future use in publications and lectures. Over two hundred negatives have been made showing the various aspects of insect life, injury to plants, and apparatus for destroying insects. Over one hundred and fifty lantern slides have now been prepared for use in lectures. Most of these are from original negatives, though a few were purchased. A small acetylene lantern was procured for exhibiting the slides at farmer's institutes, grange meetings, etc.

Between July 1st, when the law became operative, and December 31st, 1901, twenty-six nurseries were inspected and twenty-five certificates granted to nursery firms, as follows:

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Atwater, C. W.	New Haven	Oct. 8	52
Barnes, J. R.	Yalesville	Oct. 29	62
Bowditch, J. H.	Pomfret	Oct. 11	55
Burr & Co., C. R.	New Canaan	Sept. 27	47
Butler & Jewell Co., The	Cromwell	Dec. 14	65
Cheshire Nursery Co.,	Cheshire	Oct. 30	63
Comstock & Lyon	Norwalk	Oct. 28	61
Conine, Frank E.	Stratford	Oct. 7	50
Conway, W. B.	New Haven	Sept. 24	41
Crane, Stephen	Norwich	Oct. 9	53
Elizabeth Park Nursery	Hartford	Oct. 25	59
Elm City Nursery Co.	New Haven	Nov. 14	64
Gardner, R. H.	Cromwell	Oct. 10	54
Gurney & Co., H. H.	New Canaan	Sept. 27	46
Hale, J. H.	So. Glastonbury	Oct. 16	58
Hoyt's Sons, Stephen	New Canaan	Sept. 27	45
Hunt & Co., W. W.	Hartford	Oct. 3	49
Jackson, B. A.	So. Norwalk	Oct. 28	60
Jackson, E. B.	Stamford	Oct. 12	56
Longden, C. E.	North Haven	Sept. 24	44
Pierson, A. N.	Cromwell	Sept. 17	43
Platt, Frank S.	New Haven	Sept. 24	42
Purinton, C. O.	Hartford	Oct. 15	57
Veitch Co, The Robert	New Haven	Oct. 7	51
Wallace, W. E.	Hartford	Oct. 3	48

Two of the above-named firms are florists and do not handle ordinary nursery stock; frequently they have occasion to ship hardy herbaceous plants, and unless accompanied by certificates, these shipments may be "held up" in other states. The form of certificate used the past season is here given:

No..... Date..... 190..

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICE OF STATE ENTOMOLOGIST,
New Haven, Conn.

CERTIFICATE OF INSPECTION.

This is to certify that the stock at the nursery and premises of ..... of ..... Conn., has been carefully examined in compliance with the provisions of Chapter 122 of the Acts of the General Assembly at the January Session of 1901, and that no indication has been found of the presence of the San José Scale or other serious pests.

This certificate is invalid after 190

..... *State Entomologist.*

Although the majority of nurseries were in good general condition, in more than half of them the San José scale-insect was found. Only two or three were badly infested; the others were infested but slightly, the insect being usually upon stock which had been obtained from outside the state and had been planted out to remain for one or more seasons in the nursery. Several hundred trees were destroyed by the owners as advised by the state entomologist. In other cases the trees were fumigated under the writer's supervision. The owners of infested nurseries have invariably been ready to act upon the advice of the state entomologist, and have been active in attempting to rid their plantations of the insect. The writer here desires to express his appreciation of this coöperation, which is so necessary in order to make the law effective for the object for which it was enacted.

The state entomologist will endeavor to inspect, either personally or through his deputies, every nursery in Connecticut during September and October, and before the shipping season begins. He will, at any convenient time, upon request, visit any orchard, field, garden, nursery, storehouse, or greenhouse in the state, as the law provides, to investigate or give infor-

mation about any insect attacks. Specimens received by mail will be identified, and such information regarding their habits and possible remedial treatment as may be of value will be returned to the writer.

Up to July 1st, 1901, the time that the law went into effect, the San José scale had been found in 78 localities. These were mentioned in Bulletin 135, which is reproduced in this report. On December 31st, 1901, the list had been increased to 99 localities. Several extensive orchards had been found infested and in many city yards the fruit trees and ornamental shrubs were dying or already dead from its attacks.

Between July 1st and December 31st, 1901, the writer has visited 15 orchards, gardens, etc., to advise treatment, lectured at 4 agricultural meetings, identified 52 insects, and written 269 official letters.

Publications.

Bulletin 134, The New Law Concerning Insect Pests (6 pages), giving the text of the new law and a statement regarding the work planned, was issued in an edition of 10,500 copies and distributed in August.

Bulletin 135, The San José Scale-Insect: Its Appearance and Spread in Connecticut (14 pages, 5 plates), containing a general account of the insect and a brief history of its discovery and spread in the state, was distributed in December. An edition of 11,000 copies was printed.

Bulletin 136, Preliminary Experiments in Spraying to Kill the San José Scale-Insect, Season of 1901 (12 pages, 1 plate), giving an account of the experimental spraying during 1901 to kill the scale, was distributed in February, 1902, in an edition of 10,500.

Bulletins 135 and 136, with slight changes, are included in the body of this report.

Identification of Insects.

The entomologist will, so far as he is able, identify all insects which are submitted to him. It is important that the distribution of species in Connecticut be studied; specimens should, therefore, be accompanied with a statement of the exact locality and date of capture.

One hundred and seven samples of insects have been received at the station for identification, during the period of fifteen months from November 1st, 1900, to January 1st, 1902. These are given in the following list, which contains the names of the insects, locality, and food plants.

Notice to Correspondents.

In writing for information, it is of the greatest importance that specimens of the insects and of their injuries accompany the inquiry when possible. In fact it is usually necessary for the entomologist to have these before he can intelligently prescribe a treatment. Moreover the common names of insects are not constant, but vary with different localities. It is often impossible to know from the description what insect is indicated, but if specimens are sent the identity can be established. When plenty, a dozen specimens should be forwarded, and some of their food plant enclosed with them if the insects are alive.

Insects may be sent safely by mail if enclosed in a strong tin, wooden or paste-board box, which will not be crushed in transit. Do not attempt to send insects in a letter, as they are usually crushed beyond all recognition when received. It is unnecessary to punch holes in the box, because most insects can obtain a sufficient quantity of air without this precaution.

INSECTS SENT FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
1900				
Nov. 3	San José Scale,—*Aspidiotus perniciosus* Comst.	Japan plum	Bridgeport	On twigs.
" 3	Twice Stabbed Lady Beetle, *Chilocorus bivulnerus* Muls.	Japan plum	"	Pupa skins present.
" 3	Cabbage Plusia, *Plusia brassicæ* Riley	Lettuce	Hamden	Larvæ feeling in green house.
" 7	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Hartford	Twigs completely encrusted.
" 14	—— *Datana integerrima* G. & R.?	Black Walnut and Butternut	Warehouse Point	Cast larval skins, in masses on tree trunks. Caterpillar quite destructive to Black-walnut, butternut, pear and other trees.
" 21	Bee Moth, *Galleria mellonella* L.	Bee hives	" "	Pupa stage only.
" 22	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Milford	Egg stage.
" 26	Putnam's Scale, *Aspidiotus ancylus* Putm.	Mountain Ash	Norwalk	Partially grown females.
" 28	" " " "	" "	New Haven	From same stock as preceding.
" 30	San José Scale,—*Aspidiotus perniciosus* Comst.	Rose	Bridgeport	Large proportion were dead.
Dec. 3	" " " "	Peach & Plum	Fairfield	2000 peach trees infested.
" 4	" " " "	Peach	Hartford	Abundant in city.
" 11	" " " "	Peach, Pear and Apple	Meriden	Twigs were covered.
" 11	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Apple	"	Egg stage.
" 11	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	"	" "
1901				
Jan. 4	Drug Store Beetle, *Sitodrepa panicea* L.	Radish seeds	New Haven	Infesting stored seeds.
" 8	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Stafford Springs	Egg stage.
Feb. 8	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Greenwich	Twigs covered.
" 15	—— *Aphodius granarius* L.		Westville	Infesting greenhouse. Breeds in manure.
" 23	—— *Lecanium Hemisphæricum* Tar.?	Sword Fern	Suffield	Both larvæ and eggs present.
" 26	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Pear	Meriden	Egg stage.
" 26	San José Scale, *Aspidiotus perniciosus* Comst.	Pear, Plum, Peach, Apple and Currant.	"	On twigs.
Mar. 4	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Apple	"	" " Egg stage.
" 4	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Kibbe	" " " "

INSECTS SENT FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
Mar. 7	Putnam's Scale, *Aspidiotus ancylus* Putm.	Currant	Norwalk	On twigs.
" 9	San José Scale, *Aspidiotus perniciosus* Comst.	Japan Plum	Cromwell	Mostly dead.
" 11	" " " "	Currant	Bridgeport	Wood and scales dead.
" 14	" " " "	Peach	Stamford	Small twig partly covered.
" 19	Putnam's Scale, *Aspidiotus ancylus* Putm.	Currant	Westville	Both sexes present.
" 20	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Madison	Egg stage.
" 20	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Groton	Twigs thoroughly coated.
" 23	" " " "	"	Southport	" " "
April 1	" " " "	Apple	Bridgeport	" " "
" 9	——— *Achorutes diversiceps* Lint.	Soil	Woodbridge	In great numbers on moist earth.
" 11	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	New Haven	About 75 per cent. dead.
" 12	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	Preston	Egg stage.
" 12	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	"	Milford	" "
" 19	Hair Worm, *Mermis albicans?*	Soil	Bridgeport	
" 20	Snowy Tree Cricket, *Œcanthus niveus* Harr.	Peach	Yalesville	Eggs laid in peach twigs.
" 20	*Lecanium sp.?*	Bay	New Haven	In greenhouse. Immature.
" 25	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Currant	Hartford	Egg stage.
" 25	San José Scale, *Aspidiotus perniciosus* Comst.	"	"	Twig and insects dead.
" 25	Gall fly, *Rhodites radicum* Sack.?	Blackberry	"	Larvæ form galls on stem.
May 2	San José Scale, *Aspidiotus perniciosus* Comst.	Plum	Saybrook	Branch well coated.
" 3	" " " "	Plum and Pear	Shelton	Were sprayed with kerosene, insects nearly all dead.
" 3	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Grape	Higganum	Egg stage. Mostly dead.
" 3	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Shelton	" "
" 7	" " " " "	"	South Norwalk	" "
" 7	San José Scale, *Aspidiotus perniciosus* Comst.	"	"	On same twigs as preceding.
" 22	" " " "	Plum	Cromwell	Nearly all dead.
" 25	" " " "	Japan Plum	Milford	Mostly dead. Males emerging.
" 27	*Calosoma scrutator* Fabr.		Westville	
June 20	Currant Aphis, *Myzus ribis?*	Currant	Norwalk	Under surface of leaves covered with aphids.
" 21	Plum Aphis, *Aphis sp.?*	Japan Plum	Southbury	Badly infested.

INSECTS SENT FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
June 27	Elm Scale, *Gossyparia ulmi* Geoff.	Elm	New Haven	Young tree badly infested.
" 28	Tulip Tree Scale, *Lecanium tulipiferæ* Cook	Tulip Tree	South Windsor	About one-fourth size.
July 6	Brown Colaspis, *Colaspis brunnea* Fabr.	Geranium	Bristol	Eating leaves in garden.
" 6	San José Scale, *Aspidiotus perniciosus* Comst.	Currant		
		Pear, Peach	Milford	Young scales crawling.
" 19	" " " " "	Apple	Meriden	" " "
" 19	Orange Dog, *Papilio cresphontes* Cram.	*Fraxinella*	New Haven	Caterpillar eating leaves.
" 24	Pea Louse, *Nectarophora pisi* Kalt.	Sweet Peas	Bridgeport	Flowers and stems infested.
" 24	——— *Orthosoma brunneum* Forst.		New Haven	
" 24	——— *Chrysochus auratus* Fabr.		"	
" 24	Dragon fly, *Anax junius* Drury		"	
" 25	Striped Blister-Beetle, *Epicauta vittata* Fabr.	Beet & Potato	Stepney Depot	Causing considerable injury.
Aug. 2	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Japan Walnut	Westville	Few on bark.
" 2	Scurfy Bark-Louse *Chionaspis sp.?*	" "	"	Both sexes and young present.
" 6	Squash Lady-bird, *Epilachne borealis* L.	Squash	West Cheshire	Larvæ feeding upon leaves.
" 6	Striped Blister-Beetle, *Epicauta vittata* Fabr.	Cabbage and Potato	"	Adults " " "
" 6	Ash-grey " " *cinerea* Forst.	Cabbage and Potato	"	" " " "
" 7	" " " " "		West Cornwall	
" 7	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Bridgeport	Twig badly infested.
" 7	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	"	On same twigs as preceding.
" 7	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Ash	"	Twig well coated.
" 8	" " " "	Willow	Mt. Gretna, Pa.	" " "
" 22	——— *Retinia?*	Red Pine	Rainbow	Larvæ eating inside of a web near terminal bud.
" 23	Red Humped Caterpillar, *Œdemasia concinna*, S. & A.	Apple	Pomfret Center	Feeding on foliage.
" 27	White Fly, *Aleyrodes vaporariorum* West.	Aster and Chrysanthemum	Bridgeport	Larvæ and adults present.
" 30	Tent Caterpillar, *Clisiocampa Americana* Harr.	Crabapple	Milford	Eggs on twig.
" 30	Hag Moth Caterpillar, *Phobetron pithecium* S. & A.	Pear	"	Larvæ eating foliage.

Date	Name.	Host.	Locality.	Remarks.
Aug. 30	——— *Cælodasys sp.?*	Pear	Milford	Larvæ eating foliage.
Sept. 3	Hag Moth Caterpillar, *Phobetron pithecium* S. & A.	Apple	Stepney	" " "
" 6	San José Scale, *Aspidiotus perniciosus* Comst.	Pear	Southport	Newly hatched and mature scales.
" 6	Fall Web-worm, *Hyphantria cunea* Drury	Elm	Stratford	Half-grown larvæ eating leaves.
" 6	Hickory Tussock Moth, *Halisidota Caryæ* Harr.		"	Nearly full-grown larva.
" 9	Yellow-necked Caterpillar, *Datana ministra* Drury	Apple	New Preston	Larvæ feeding on foliage.
" 10	Hag Moth Caterpillar, *Phobetron pithecium* S. & A.	Rubber Plant	Clarks Corner	Single larva, full-grown.
" 10	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	West Hartford	Twigs badly infested.
" 14	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	New Haven	
" 18	Orange Dog, *Papilio cresphontes* Cram.	Orange	Woodbridge	Larvæ eating foliage of a house-plant set out of doors.
" 21	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Apponaug, R. I.	Twigs badly infested.
" 28	Giant Hornet, *Vespa crabro* L.	Pear	Whitneyville	Eating ripe fruit.
Oct. 5	Saddle-Back Caterpillar, *Empretia stimulea* Clem.	Corn	Yalesville	Larva eating leaves. No letter of explanation.
" 5	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Branford	Eggs are now being formed.
" 9	" " " "	"	Kent	Eggs not formed.
" 10	*Scutigera forceps* Rafin.		New Haven	Nuisance in dwelling house.
Nov. 7	Quince Curculio, *Conotrachelus cratægi* Walsh.	Quince	"	Larvæ inside the fruit.
" 19	Mole Cricket, *Gryllotalpa sp.?*	Orange	Bayamon, P. R.	Destroyed thousands of seedlings.
" 19	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Riverpoint, R. I.	On Twigs. Some dead.
" 19	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	" "	Egg stage.
" 20	San José Scale, *Aspidiotus perniciosus* Comst.	Pear	Cheshire	On Twigs.
" 29	" " " "	Plum and Crabapple	Southport	" "
Dec. 3	*Chrysomphalus (Aspidiotus) ficus* Ash.	*Ilex crenata*	Westville	On leaves. Plants imported from Japan.
" 3	*Ceroplastes sp.?*	" "		On leaves. Plants imported from Japan, material immature.
" 16	White Marked Tussock Moth, *Notolophus leucostigma* S. & A.	Apple	Pomfret Center	Egg masses.
" 16	Apple Aphis, *Aphis sp?*	"	"	Eggs fastened around buds.
" 16	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Lilac	Southport	Egg stage.

THE SAN JOSÉ SCALE-INSECT; ITS APPEARANCE AND SPREAD IN CONNECTICUT.*

No other insect has caused so much destruction in fruit orchards throughout the country as the San José Scale (*Aspidiotus perniciosus* Comst.). This scale was first noticed by fruit shippers near San José, Cal., and was described by Prof. J. H. Comstock, in 1880. It was at that time doing much damage in California, and Prof. Comstock regarded it as the most destructive scale-insect which he had seen.

For several years the original habitat of this insect was undetermined, but recent observations point toward China as the probable country of its origin.†

Introduction into the Eastern States.

Though it caused much damage to fruit trees in California for several years, the scale was not known to exist in the Eastern States, until discovered in August, 1893, at Charlottesburg, Va. In March, 1894, an infested locality was found at Riverside, Md. In both cases, the introduction of the insect was traced to New Jersey nurseries, which had received the scale on nursery stock from California. Another infested area was discovered in March, 1894, at De Funiak Springs, Fla. Shortly afterwards Indiana, Pennsylvania, New Jersey, New York, Georgia, Ohio, Delaware and, in the summer of 1895, Alabama, Louisiana, Connecticut and Massachusetts were added to the list of infested states. At the present time, the San José Scale exists in nearly every portion of the United States, the extreme Northern states alone, perhaps, being exempt.

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*Published as Bulletin 135, December, 1901. It is here reproduced in slightly amended form.

†At a meeting of the Biological Society of Washington, D. C., held Nov. 16th, Dr. L. O. Howard stated "that he had received a letter from Mr. C. L. Marlatt, announcing the discovery of the long-sought original habitat of the San José scale-insect; this was found to be in China, in the region to the South of the Great Wall. The scale-insect was preyed upon by a species of ladybird beetle, living examples of which were now on their way to the United States."—Science, Vol. XIV, No. 362, p. 895, Dec. 6, 1901. See also Report of the Secretary of Agriculture for 1901, page xcvii.

Discovery and Distribution in Connecticut.

Ten years ago the San José or pernicious scale-insect was introduced into Connecticut on nursery stock from New Jersey. It escaped notice, however, until June 12th, 1895, when it was discovered at New London by Dr. W. C. Sturgis, botanist of this Station. The insect had then been multiplying for four years in the orchard and garden of Mr. J. L. Raub, and several trees had been killed by it. A study of the locality was made and a bulletin was issued, calling attention to the presence of the insect in Connecticut, describing its appearance and injuries, and giving the best remedies known at that time. (See Bulletin No. 121, July, 1895.)

Soon after, specimens were received from Hartford and Bridgeport. During 1896, additional centers of infection were found at Darien, New Haven, Groton, Mystic, Farmington, New Britain, Plantsville, and in the following year, Meriden, Wallingford, Hamden, Woodbridge and Greenwich were added to the list. The scale was found in Ivoryton, Nichols, Cheshire, Burnside and Rowayton during 1898, and in several new localities in New Haven, Hartford and Bridgeport. Previous to July 1st, 1901, when the Insect Pest Law became operative, the San José scale had been found in seventy-eight localities in this State. The names of the towns and the number of infested localities in each town are as follows:

Ansonia—1, Berlin—1, Branford—1, Bridgeport—6, Burnside—1, Cheshire—1, Cromwell—2, Darien—2, East Haven—1, Fairfield—1, Farmington—1, Greenwich—2, Groton—2, Hamden—1, Hartford—8, Ivoryton—1, Lebanon—1, Lyme—1, Meriden—3, Milford—3, New Britain—1, New Canaan—1, New Haven—12, New London—3, Nichols—1, Norwich—1, Old Mystic—2, Plantsville—1, Rowayton—1, Saybrook—1, South Glastonbury—1, Shelton—1, South Norwalk—3, Southport—1, Stamford—1, Stratford—2, Terryville—1, Wallingford—1, Waterbury—1, Woodbridge—2.

In a few of the places noted, the insect was discovered before it had infested more than one or two trees. The immediate destruction of these infested trees has probably wiped out the pest from a very few localities, but in most cases the scale had spread to a serious degree before it was discovered, and many trees have been killed and a still greater number badly injured by its attacks.

Nursery Inspection in Connecticut.

Inasmuch as this insect has been distributed chiefly by means of nursery stock, several states previous to 1896 passed laws requiring that all nursery stock shipped into these states should be accompanied by a certificate of inspection issued by some authorized inspector. In the absence of any provision for the inspection of nursery stock in this State, Connecticut nurserymen were debarred from shipping stock into the states above referred to. During the season of 1897, the Station was first requested by Connecticut nurserymen to examine their stock and grant certificates, if not found to be infested. The Station complied as well as it could with the means at its command, and as requests for inspection grew more numerous, early in 1899 the Board of Control formally adopted regulations regarding such inspection and the granting of certificates. A circular embodying these regulations was printed and mailed to about seventy nurserymen, seedsmen and dealers in plants. In May, 1899, a bulletin on Inspection and Care of Nursery Stock, containing the Inspection Rules, was published and distributed. Up to the time the present law went into effect, about fifty inspections had been made and thirty-nine certificates granted. While this arrangement enabled the Connecticut nurserymen to ship into other states, it did not protect the buyers of nursery stock living within the State. If a nursery was badly infested, so that a certificate could not be granted, the owner could sell his plants and trees in Connecticut, where a certificate was not required. There was also nothing to prevent the shipping of infested stock into this State from those states which had no nursery inspection laws.

Legislation.

The fruit growers of Connecticut, represented by the State Pomological Society, urged the passage of a law regarding insect pests, chiefly because of the damage caused by the spread of the San José scale. The question was discussed at the annual meeting of the society in February, 1901, at Hartford, and the present law is the outcome of this agitation. This law was published in July, in Bulletin No. 134, of this Station. The law provides for the study of other pests as well as the San José scale. At the time the Connecticut law was enacted, at least twenty-five other states had passed similar measures.

Life History of the San José Scale.

Both the males and females pass the winter in an immature state, and do not reproduce until the latter part of June in this latitude. The present year, young were first observed on June 27th. The female does not lay eggs, but brings forth living young. The newly-born scales of both sexes crawl about for a few hours upon the twigs. They are provided with legs, eyes, antennae and mouth-parts. After they have found a suitable place, they settle upon the bark, insert their beaks and begin to suck the juice from it. Legs and antennae now disappear in both sexes, and the females lose their eyes. At first there is a white waxy substance exuded, which has somewhat the appearance of wool. A little later this seems to melt down and the insect casts its skin. The skin, together with the waxy substance, forms the beginning of the shell or covering. After feeding for about four weeks, the insect reaches the full-grown stage. If a female, it then begins to bring forth its young, continuing for a period of about six weeks. The number of young produced by a single female varies from less than one hundred in the early part of the season to nearly six hundred in late summer. The male feeds until full-grown, passes through the pupa stage, and finally the adult comes forth from under the shell, provided with eyes, wings, legs, antennae and organs of reproduction, but with no mouth-parts nor digestive system. He can, therefore, eat nothing after reaching the adult stage. His only mission is to mate with the female and die. The female, on the other hand, after becoming established upon the twig, loses legs, antennae, and eyes, never again to be possessed of these organs, while its mouth-parts, digestive system and reproductive organs become very strongly developed. It cannot therefore move about, but feeds upon the juices of the plant and reproduces its kind. There are three complete generations each season in this latitude, and probably four in favorable seasons.

General Appearance of the Insect.

Usually the insect appears upon the bark as a greyish, rough coating, scarcely noticeable to the naked eye. At first there are but few individuals, generally found clustered around the

buds and at the branching of the twigs. Plate III, a, shows how the scales collect in a groove or hollow in one side of a twig, as if they had sought a sheltered situation. As the trees become more thoroughly infested, the bark may be completely covered, and sometimes there are several layers of scales covering the bark. In such cases leaves and fruit are usually attacked. The

Fig. 1. Appearance of San José scale on peach twig. a. mature females: b. young females: c. immature males. About twice natural size. *Wood-cut from author's drawing.*

young scales locate upon both sides of the leaf, along the ribs (see Plate V, b), where they cause a reddish discoloration. This discoloration also occurs on fruits, and on the twigs, especially where there are but few individuals, and it is apparent not only on the outside, but extends through the bark to the wood.

Where the insect is found upon the fruit, it seems to prefer the calyx and the stem cavities. Upon slightly infested trees the fruit is not attacked, but on trees which are badly infested the fruit is often so thoroughly covered as to present a very disgusting appearance. (See Plates IV and V.) If we examine the insect through a pocket lens, magnifying perhaps ten diameters, we see that it is distinctly circular in outline, somewhat raised above the bark, especially in the center where there is a small nipple, differing in color from the other portion. If infested twigs are much handled, the outer layer is rubbed away from the nipple, leaving it a bright yellow color. Concentric circles are usually apparent between this nipple and the outside edge. The scaly covering is formed at the edge in concentric layers or additions. The covering of the male is different in shape from that of the female. While that of the female is nearly circular in outline, the armor of the full-grown male scale is nearly always elongated, with the nipple near one end, and the lines of formation are eccentric instead of concentric. (See Fig. 1.)

The color of the shell or covering varies greatly, sometimes being a light grey, sometimes being nearly black. It frequently turns dark if the insects are killed when half grown. If killed when fully grown, the shells often assume a light grey color, and finally drop from the twigs. If we lift this shell or covering with a pin or point of a knife, we will see underneath a small yellow object, oval or circular in outline, which appears like a bit of yellow jelly. This is the insect proper and is shown in the illustration on Plate III, a.

Food Plants.

According to Howard* and Lintner† the scale occurs on the following plants: Apple, pear, quince, peach, plum, cherry, mountain ash, hawthorn, Japanese quince, linden, *Euonymus,* almond, apricot, *Spiræa,* raspberry, rose, cotoneaster, gooseberry, currant, flowering currant, persimmon, acacia, lilac, elm, osage

* Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture, Washington, D. C., p. 38.

† Bulletin of the New York State Museum, Vol. 3, No. 13, p. 295.

orange, English walnut, pecan, weeping willow and laurel-leaved willow.

In addition to the above-mentioned food plants, Rolfs and Quaintance* give chestnut, black walnut, Carolina poplar, Lombardy poplar, cut-leaved birch, flowering cherry, flowering peach, grape, *Catalpa,* and sumac.

In Connecticut, the writer has found it upon apple, quince, pear, peach, cherry (sweet), plum (European, Japanese and purple-leaved), hawthorn, mountain ash, Japanese quince, *Spiræa,* rose, currant, gooseberry, poplar, honey locust, choke cherry, shad-bush or June berry, cut-leaved white birch, dogwood, Japanese walnut, elm, grape, California privet, and several species of willow. In Hartford the scale has already attacked the wild choke-cherry and shad bushes in sprout-lands. While the insect usually attacks plants belonging to the Rose family, there is reason to believe that it may attack any species adjacent to infested trees. Of the orchard trees, Japanese plum, pear, apple, quince and peach, are most often infested, while the cherry and European plum are less frequently attacked.

The purple-leaved plum is perhaps the most subject to attack of all the ornamental plants. Mountain ash, hawthorn, and *Cydonia* are, however, frequently injured by it.

How the Scale Spreads from Tree to Tree.

The young scales crawl about for a few hours on the bark, and if the trees stand so close that the branches interlace, of course they can readily crawl from one to the other. They are scarcely able to crawl long distances from the trunk of one tree to another over the rough ground, but are often blown about on fallen leaves and may reach a different section of the orchard in that way. In cultivating nurseries, the workmen brush against the young trees, and it is quite possible for some of the young insects to be carried to other trees along the nursery rows.

In one case, an orchard became infested by hitching a horse to one of the trees, after the team had been in an infested orchard three miles distant.† The throwing about of infested fruit may

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*Coccidæ Americanæ, Decades I and II, No. 15.

†Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture, Washington, D. C., p. 50.

aid in distributing the pest. Also where parings of infested fruit are thrown out into gardens, there is danger that near-by trees may become infested.

As a rule, however, the insect is carried to distant trees either by other insects or upon the feet of birds.

Effect upon Trees.

The effect on the vitality of the tree is not apparent until the twigs become nearly covered by the insect. Then it may be noticed that the tree seems unthrifty, but the scale is so inconspicuous that frequently the tree loses some of its branches or dies before the cause of the trouble is discovered. The illustration on Plate II shows a peach tree which has been severely injured, and the branches are dead, but the trunk is still alive and making an effort to grow a new top. This form of injury is one often seen, and frequently the owner does not discover the cause until his trees reach this condition. A plum tree killed by the scale is shown on Plate I. The length of time required to kill a tree depends on various factors. In certain seasons the species multiplies much more rapidly than in others, depending undoubtedly upon the weather and the abundance of natural enemies. The writer has known of several localities where ornamental plants were attacked and no measures taken to destroy the scale, yet for two or three years the insect has not spread to any appreciable extent. On the other hand, in certain orchards, it has spread with great rapidity in spite of vigorous combative measures. In Mr. Raub's garden at New London, large peach trees were killed by the scale in four years.

Remedies.

All infested trees which are worthless or of little value should be destroyed, as the owner cannot afford to treat them; he had better obtain new trees.

Spraying.

There have been many different applications used in Connecticut to kill this scale-insect. The most successful, perhaps, is either crude oil, applied just before the leaves are put out in the

Spring, or a mixture of kerosene and water (20 to 25 per cent. kerosene), applied at the same time. The crude oil possesses one advantage. A portion of it stays on the bark for several months, so that it would seem impossible for the young scales to become established. Kerosene, on the other hand, evaporates readily and, after a few weeks, can not be detected by odor or by the appearance of the twigs. Experiments conducted by us during the past season, show that either the crude oil, or 20 per cent. kerosene and water, if thoroughly applied, will kill the insects without causing any serious injury to the trees. An account of these experiments will appear in a forthcoming bulletin. It is not safe to apply any form of petroleum on a damp, cloudy day. It must be used in pleasant weather, and must be applied in the form of a fine spray.

We have found the "Kerowater" barrel pump, made by the Goulds Mfg. Co., Seneca Falls, N. Y., to give satisfaction in orchard work. For a few small trees in the garden there is probably nothing better than the "Success" bucket pump made by the Deming Co., Salem, Ohio. These pumps are not kept in stock by local dealers, but must be ordered from the manufacturers. The "Vermorel" is the best nozzle we have employed for kerosene spraying, but a cap with small aperture should be used. In infested orchards this spraying is likely to be adopted as the best practical way of holding the pest in check. Fumigating is here too expensive.

According to experiments made in New Jersey, certain grades of crude oil are liable to cause injury to the trees. If the oil has a specific gravity of not less than 43° (Beaumé), there is little danger. It need not be above 45° however. As the term "crude petroleum" is rather vague in meaning, it is necessary to specify, in ordering, what grade of oil is required. In order that Connecticut fruit growers may obtain the proper grade of oil for insecticide purposes, I have arranged with the Standard Oil Company to furnish it. Orders should be sent to the Providence Department of the Company, Mr. P. M. Watt, Manager, 136 South Water St., Providence, R. I. This oil is not kept in stock at the distributing stations, but shipments can be made quickly from New York. The present price is 9½ cents per gallon, including barrel, but of course the price is subject to changes. In ordering, call for "Insecticide Oil."

A solution of whale-oil soap (2 lbs. of soap to 1 gallon of water) sprayed upon the trees is regarded as the best remedy in many localities. It is probably less liable to injure trees than the kerosene or crude oil, and may be applied at any time during the winter. But it is an expensive treatment for large orchards, and from our observations in Connecticut it does not seem to be as effective in destroying the insects as kerosene or crude oil. It is also difficult to apply in the form of a spray. Whale-oil soap fairly uniform in composition may be obtained from the manufacturers, James Good, 514-518 Hurst St., Philadelphia, Pa., and Leggett & Bro., 301 Pearl St., New York.

The above-mentioned treatment applies only to dormant trees. If the insect is discovered during the Summer when the trees are not dormant, it may be held in check for the season by spraying with 15 per cent. kerosene and water, or whale-oil soap solution (1 lb. to 5 gallons of water), which will kill most of the young scales which are crawling upon the bark.

Fumigating.

In nurseries where the trees are dug up in shipping season, the scales upon them can easily be destroyed by fumigating with hydrocyanic acid gas. A tight box, tent, or room, is required for this purpose, and our leading nurserymen are now provided with some sort of equipment for fumigating their nursery stock. In fact, some of their large orders reach them with the request that the stock be fumigated before being sent out: even when it is not known to be infected. The formula which we have been using in Connecticut requires for each 100 cubic feet of space,

Cyanide of potash (97 per cent.)	25 grams, ⅝ oz. (by weight)
Sulphuric acid (Sp. G. 1.83)	1¼ oz. (liquid measure)
Water	1⅞ oz. (liquid measure)

The enclosed space should be computed with care, and the chemicals measured out accordingly. The house should of course be filled with the trees before preparing the chemicals. A stoneware jar of suitable size makes a good generator. The water should first be put into this jar and the acid poured in slowly with constant stirring. The jar should be set inside, and within

easy reach of the door or cover. The cyanide is then dropped into the jar quickly, and the house closed from the outside. The person should leave at once, as the fumes are extremely poisonous and might cause death if one should breathe them. The trees should be left for half an hour, when the house may be opened in order to let the fumes escape. It is not safe for persons to enter for several minutes. While this treatment is not certain to kill every individual scale-insect, it is one of the surest methods that we know of destroying them. Small orchard trees can be fumigated in this manner, by covering them with a gas-tight tent, beneath which the gas is generated, but for large orchard trees, an expensive outfit is required to handle the tents. There is also some difficulty in computing the space. Chiefly on account of the expense, however, this has not been practiced to any extent in Connecticut. The fumigation of nursery stock must be, from now on, a common practice. The materials may be obtained from any wholesale druggist. A fumigating house is shown on Plate XI.

Summary.

(1) The San José Scale appeared and caused much destruction of fruit trees in California twenty years ago. China is probably the country of its origin.

(2) It was first found in the Eastern states in 1893, and now occurs in nearly all the states of the Union, except perhaps, the extreme Northern ones.

(3) The scale was brought into Connecticut on nursery stock ten years ago, but not discovered until 1895. Seventy-eight infested localities had been found up to July 1st, 1901, when the new Insect Pest Law went into effect.

(4) The Station began the work of inspecting nurseries in 1897, at the request of nurserymen. This enabled them to ship stock into other states where inspection laws existed. Fifty inspections were made and thirty-nine certificates granted under this arrangement. Twenty-five other states had enacted inspection laws, before the Connecticut law was passed.

(5) The full-grown female scale gives birth to living young, which crawl about for a short time and then settle upon the bark. There are three or four generations each season. They feed by sucking the juices from the tree. Each female may produce from less than one hundred to six hundred young.

(6) The scale is inconspicuous and is seldom noticed until the vitality of the tree is impaired, at which time the bark is usually coated with a roughish grey substance. The reddish discoloration may be found around each individual. Leaves and fruit are also attacked. The female scale is nearly circular in outline, while the male is somewhat elongated. If the scale is lifted, the insect proper may be seen underneath, by the aid of a lens, as a yellow object.

(7) Common fruit trees and plants of the Rose family are usually preferred by the insect, but it is liable to attack almost anv variety of tree or plant that may be growing near infested trees.

(8) Though the young scales crawl short distances, they are usually carried from one tree to another by other insects, or upon the feet of birds. They may also be carried upon fallen leaves, fruit, or the clothing of persons, etc.

(9) The vitality of the tree is gradually lessened by the hordes of insects sucking its sap. The pest is seldom noticed until some of the twigs die. Entire trees have been killed in four years in Connecticut by the scale.

(10) Spraying the trees just before leaves appear in the Spring, with crude oil, or with a mechanical mixture of kerosene oil and water, using 20 per cent. kerosene, is the best remedy that we can now recommend for large orchard trees.

Whale-oil soap and water, in the proportion of 2 lbs. of soap to 1 gallon of water, sprayed upon the dormant trees, is also an effective treatment. Growing trees may be treated with 15 per cent. kerosene and water, or whale-oil soap (1 lb. in 5 gallons of water). For nursery stock, fumigating with hydrocyanic acid gas is the cheapest and most effective treatment.

PRELIMINARY EXPERIMENTS IN SPRAYING TO KILL THE SAN JOSÉ SCALE-INSECT. SEASON OF 1901.*

The contradictory results obtained by different experimenters, even within the limits of a single state, regarding the effect on trees of crude petroleum and kerosene, indicate that these materials should be tested in each locality before we can wisely recommend their use. It is certain that trees have been injured and even killed by applications of these oils, while in hundreds of other cases no injury could be detected. It is quite probable that climatic influences, such as temperature, humidity, altitude, exposure, etc., may be responsible for the varying results. To study some of these points as well as to note the effects on the insect, careful tests were made the past season in three different localities, all situated near the coast.

In each of the experiments at Westville, Stratford, and East Haven, the twigs were examined before insecticides were applied, and the percentages of living scales noted. A month or six weeks after spraying, twigs were again taken from these trees and the percentages of living scales again determined, thus giving some idea of the effect of the treatment upon them. It is not claimed that the percentages exactly represent the conditions of the insects on the whole tree in each case, as it is difficult to obtain twigs that can fairly stand for all conditions of exposure, etc., to which the tree is subjected. On some twigs the scales were nearly all dead, while on others most of them were alive. As a number of twigs were selected in each case and as judgment was used in making this selection, it is believed that the average figures are approximately correct, and show the results of the treatment much more accurately than any mere estimate not based upon actual enumerations.

The kerosene used was taken from a barrel purchased for illuminating purposes, branded "Devoe's Brilliant Oil," and claimed to have a fire test of 150°.

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* This matter was printed as Bulletin 136 and distributed in March in an edition of 10,500 copies. It is here reproduced with appropriate emendations.

The crude oil was obtained from the Standard Oil Co. and shipped to us from Providence, R. I., after being ordered from Philadelphia, Pa., according to arrangements made by Professor J. B. Smith of New Jersey. This oil had a specific gravity of very nearly 43° Beaumé. Anyone desiring crude oil for insecticide purposes, may obtain it from Mr. P. M. Watt, Manager, Providence Department, Standard Oil Co., 136 South Water St., Providence, R. I., and it should be ordered as "Insecticide Oil."

The soap used in these tests was the "Welcome," a brand in common laundry use. Any similar hard soap would doubtless answer the purpose quite as well.

The Babbitt's lye was the commercial product put up in tin cans for household use and labeled "Babbitt's Potash or Lye." It consists of soda, however, instead of potash.

The extensive orchard work, both at Westville and Stratford, was done with the "Kerowater" barrel pump made by the Goulds Mfg. Co., Seneca Falls, N. Y.

In the more careful tests, where only a few trees were sprayed, the "Success" bucket pump was used. This pump is manufactured by the Deming Co., Salem, Ohio.

Westville Experiments.

The first experiments were conducted on dormant trees at Westville. The applications were made on April 12th, which was a bright day with a moderate breeze. The materials used were: 1, kerosene and water in mechanical mixtures (containing 15 and 20 per cent. of kerosene), 2, crude oil, and 3, Babbitt's lye—one pound to four gallons of water. With the exception of a peach tree sprayed with crude oil, all the trees were drenched, great care being taken to cover every portion of the bark.

These tests on a few trees were made by the writer with the greatest care. The owner sprayed his entire orchard, using the 20 per cent. mixture of kerosene and water on most of the trees, and a 25 per cent. mixture on the remainder.

Plate VI (*b*) shows the appearance in July of a peach tree sprayed with crude oil, and (*a*) shows at the same time a tree sprayed with 20 per cent. kerosene in water. Both trees were sprayed on April 12th.

Table I shows the number and kinds of trees treated, materials applied, what percentage of the total number of scale-insects found on the twigs were living at the time they were examined, condition of trees at time of application, and the percentage of insects found alive after the application, percentage probably killed by the treatment, and the effect of the treatment upon the foliage, etc.

By consulting the table, the reader will see that in case of the pear tree drenched with the crude oil less than one per cent. of living insects was found when examined on July 3d. This may be somewhat misleading, but it should be remembered that the figures represent only a single tree. The percentage of living insects was even lower (.043 per cent.) on one of the pear trees treated with the kerosene and water mixture having 20 per cent. of kerosene, though the average of the three trees was much higher (3.07 per cent.). The results also indicate that 15 per cent. of kerosene in the kerosene and water mixture is fatal to most of the scales at this time of the year and under these conditions. Crude oil does not evaporate as readily as kerosene and remains on the bark for several months, thus preventing many young scales from becoming established.

Babbitt's lye of the strength used, and on the single pear tree, was less effective in destroying the scales than crude oil or the kerosene and water mixture containing 20 per cent. of kerosene.

Experiments at Stratford.

After the foliage appeared, an orchard in Stratford was found to be infested with scales, and experiments were made there, to note the effect of the insecticides upon both the foliage and insects. Spraying was done on June 19th, in pleasant weather. The application used consisted of 15 per cent. kerosene in water on a large number of trees. On a single tree each, mixtures of crude oil and water containing 30, 20, and 15 per cent. of crude oil were used. The entire orchard, containing over three hundred trees, was sprayed, more than two-thirds (220 trees) with 15 per cent. of kerosene in water, and the remainder (85 trees) with 15 per cent. of crude oil in water, the trunks and bases of the branches being covered with the insecticide, but care was taken that it should not reach the foliage.

TABLE I.—WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 12TH, 1901.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on June 3d.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined June 3d.
1	Peach.	Badly infested	No treatment	76	83.6	0	
1	"	Moderately infested	15 per cent. kerosene in water.	79.8	8.4	71.4	No perceptible effect.
3	"	" "	20 " " " "	84.3*	5.8*	78.5*	" "
1	"	Slightly infested	Crude oil. Surface of trunk and branches moistened	80	5.4	74.6	No injury.
1	Pear.	Moderately infested	15 per cent. kerosene in water.	82	3.9	78.1	" "
3	"	" "	20 " " " "	81*	3.07*	78*	" "
1	"	Badly infested	Crude oil. Tree drenched	83	.1	82.9	Injury very slight. A few buds were destroyed.
1	"	Moderately infested	Babbitt's lye. 1 lb. to 4 gal. water	85	12.6	72.4	No injury.
1	Crab-apple.	Badly infested	20 per cent. kerosene in water.	89.3	8.7	80.6	" "

* These figures represent the average percentages from three trees.

At this time the first brood of scales had not appeared.

From an examination of Table II, it may be seen that the various mixtures of crude oil with water caused injury to the foliage and fruit, to such an extent as to prohibit its use on peach trees in leaf, though it must be admitted that it was rather more effective in killing the insects than the kerosene and water mixtures. The soap and water injured the foliage about as badly as crude oil and water. The kerosene and water mixture, containing 15 per cent. of kerosene, caused practically no injury on peach trees in foliage.

East Haven Experiments.

The third series of experiments was carried out at East Haven on trees in foliage, June 26th. 15 and 10 per cent. of kerosene mixed with water, and the same proportions of crude oil and water, and the soap solution (one pound of soap to eight gallons of water) were used. The next day after applying these insecticides (June 27th), the young insects began to appear, not having been seriously injured before birth by the applications.

The tests at East Haven (see Table III) gave results very similar to those obtained at Stratford as regards the effect of kerosene and crude oil mixtures on both the San José scale insect and the peach trees. Soap and water injured the leaves as much as crude oil, though less destructive to the scale.

Other Records.

A purple-leaved plum tree, growing in New Haven and badly infested with the scale, was treated on July 24th with a kerosene and water mixture containing 15 per cent. of kerosene. The weather was fair with a moderate breeze. The treatment was very thorough, and the mixture made to cover every portion of the tree until it dripped from the branches. On August 28th, twigs were cut from the tree to ascertain the effect of the treatment. Of three hundred and eight (308) individuals examined, only three were alive. The tree shed a few leaves but did not appear to be damaged to any serious extent.

During the latter part of the winter, currant twigs received from Bridgeport were found to be infested with the San José

TABLE II.—STRATFORD EXPERIMENTS. TREES IN FOLIAGE, SPRAYED JUNE 19TH, 1901.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on July 9th.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined July 9th.
2	Peach.	1 badly infested; 1 not infested	15 per cent. kerosene in water. Entire tree drenched.	Not taken.	Not taken.	Not taken.	A few leaves and young fruits dropped. Practically no injury.
3	"	Badly infested.....	15 per cent. kerosene in water. Entire tree drenched.	91.4	33.3	58.1	A few leaves and young fruits dropped. Practically no injury.
1	"	" "	15 per cent. crude oil in water. Entire tree drenched.	88.6	24	64.6	Caused injury to lower leaves, fruits and a few tender shoots.
1	"	" "	20 per cent. crude oil in water. Entire tree drenched.	87.5	11	76.5	Took off most of the foliage. New leaves are putting out.
1	"	Badly infested. Entire top had been cut off and only trunk and new shoots remained.	30 per cent. crude oil in water. Entire tree drenched.	Not taken. Nearly all dead on twig examined.	Not taken.	Not taken.	Tree severely injured.
3	"	Badly infested.....	1 lb. soap in 8 gal. water. Entire tree drenched.	80.8	27	53.8	Severe injury. Nearly all the fruit spoiled and lower leaves gone. New shoots killed. Only leaves on topmost branches remain.
220	"	Moderately infested	Trunk and branches (not the foliage) sprayed with 15 per cent. kerosene in water.	Not taken.	Not taken.	Not taken.	Practically no injury. A few leaves dropped.
85	"	Moderately infested	Trunk and branches (not the foliage) sprayed with 15 per cent. crude oil in water.	Not taken.	Not taken.	Not taken.	Some injury. Leaves and young fruit were killed where the spray came in contact with them.

scale. The owner sprayed his plants carefully, on March 12th, using a soap emulsion of kerosene containing 25 per cent. of kerosene. The weather was fair, and in most cases the twigs were so covered that the emulsion dripped from them. Fifteen gallons of the mixture covered five hundred currant bushes, and was applied with a Garfield knapsack sprayer. Twigs were examined at the Station, on May 22d, and it was found that less than one per cent. of the scale-insects were alive.

This form of treatment does not require the special pump for mixing kerosene and water, but the emulsion may be applied with any spray pump.

Effect on Trees.

The peach leaves were somewhat injured by the insecticides. It is known that peach foliage is very susceptible to most spraying mixtures, and that Bordeaux mixture, which is commonly used on the foliage of most fruit trees, cannot be used safely upon peach trees in this climate. Crude oil in all the percentages used caused injury, though the 15 per cent. mixture was scarcely more injurious than the mixture containing 10 per cent. of oil.

The soap and water caused as much injury as the crude oil, but was not as effective in killing the scales. Leaves injured by the applications became ragged and perforated, portions of the tissue being killed and falling away, much resembling those attacked by the shot-hole fungus. These leaves turned red and dropped later. In some cases the young fruits were killed by the application, and these shriveled and afterwards dropped; the young twigs were also killed but the hardened growth remained uninjured. At first it was thought that the kerosene and water mixtures had caused injury, but only a few leaves dropped and it is doubtful if the trees were really injured at all; much less so, unquestionably, than would be the case were the scales allowed to multiply unchecked.

We are not yet able to make any statement regarding the effect on trees of repeated applications of kerosene or other mineral oils. Further experience is necessary to determine this point. Thus far, however, it seems fairly safe to apply kerosene and water in a 15 per cent. mixture to fruit trees in foliage, and

TABLE III.—EAST HAVEN EXPERIMENTS. TREES IN FOLIAGE, SPRAYED JUNE 26TH.

Number of trees treated.	Kinds of trees.	Condition of trees before treatment.	Treatment and materials applied.	Percentages of living insects at time of treatment.	Percentages of living insects on Aug. 2d.	Percentages of insects probably killed by treatment.	Effect of treatment on trees. Examined July 3d.
2	Peach.	Partly dead. Badly infested.	15 per cent. kerosene in water	72.7	28	44.7	Injury very slight; not worth considering.
2	"	1 partly dead, badly infested, 1 in good condition, moderately infested.....	10 " " "	82	34	48	No perceptible injury.
2	"	1 unthrifty with "yellows," 1 quite vigorous, both moderately infested	15 Crude oil in water.....	76.7	23	53.7	A few tender shoots, leaves and young peaches killed.
2	"	Quite vigorous. Moderately infested	10 " " "	83.5	20	63.5	Slight injury to new growth leaves and fruit.
2	"	1 partly dead, badly infested. 1 in fair condition, moderately infested.....	1 lb. soap in 8 gals. water....	86.5	73	13.5	This application seemed to injure foliage and fruit as much as 15 per cent. crude oil in water.

our experience indicates that the scale may be held in check to a considerable extent by so doing, especially if the application be made after the breeding season of the insect begins, or during the latter part of the summer.

We were not able to detect any considerable injury to the dormant trees by any of the insecticides applied just before the buds opened in the spring.

Effect of the Treatment upon the Scale-Insect.

It may be seen from the tables that both the crude oil and 20 per cent. kerosene mixture were effective in destroying the scale when applied to dormant trees late in the spring. The same materials did not kill the scales as satisfactorily when applied in June. We are unable to give a reason for this, but it may be due to the condition of the insects, which at the time of spraying in April were mostly females, nearly mature, and about ready to give birth to their young. In both cases, at East Haven and Stratford, the treatment killed a much smaller percentage of the insects than similar applications to dormant trees in April, or to trees in foliage during the latter part of July. Had the spraying been done a few days later, and when the young were crawling, it would unquestionably have killed nearly all the young scales, and even the spraying late in July was very effective in destroying both the young and mature insects.

Summary.

(1) Contradictory results regarding the effect of mineral oils on trees rendered it essential that tests be made in each locality before the use of such oils be recommended. Such experiments have been conducted the past season in three localities near the coast.

(2) Twigs were taken from each tree and the insects examined before treatment; another examination was made a month or six weeks later and percentage of living insects noted in each case to determine the effect of the treatment.

(3) Crude oil, kerosene and water, with 15 and 20 per cent. of kerosene, and Babbitt's lye, one pound to four gallons, was used on dormant trees at Westville just before the leaves appeared in spring. Kerosene and water mixtures, and crude

oil and water mixtures, that contained oil in proportions from 10 to 30 per cent., and soap and water (one pound of soap to eight gallons of water), were used on peach trees in foliage at Stratford and East Haven.

(4) Crude oil having a specific gravity of 43° Beaumé, and a kerosene and water mixture containing 20 per cent. of kerosene, were both effective in destroying the San José scale where applied to dormant trees just before growth started, and did no apparent harm to the trees. Babbitt's lye in the strength used was much less effective.

(5) The scale may be held in check on peach trees in foliage by spraying with kerosene and water mixture containing 15 per cent. of kerosene without serious injury to the trees, but was not as effective in destroying the scale when applied during the latter part of June as when applied a month later. 15 and 10 per cent. of crude oil mixed with water caused injury to peach foliage and is not to be recommended: the same may be said of common soap and water (one pound to eight gallons).

(6) Kerosene emulsion containing 25 per cent. of kerosene is effective in destroying scales on dormant trees and may be applied with any form of spray pump.

CARNATIONS INJURED BY THE VARIEGATED CUT-WORM.

Peridroma saucia Hübn.

During January, 1901, caterpillars of this species attacked a bench of carnations, which were grown for experiment in the station forcing house. Leaves were not eaten to any extent. Each of a few flowers had a hole eaten into the calyx and the lower portions of the petals eaten off, allowing the detached portions to drop to the ground. The unopened buds were the chief objects of attack, and about 60 of them were ruined. In each case a hole was eaten in the side of the bud and the contents devoured.

The night watchman was instructed to hunt for these cut-worms while making his rounds of the houses.

The first larva was found January 25th, and during the next two weeks several were taken from the plants. Some of these soon pupated and the adults emerged on March 27th.

The cut-worms appeared only in that part of the bench which

was filled with street sweepings, which had been composted for a short time before filling the house. As the caterpillars were nearly full-grown when discovered, and as the plants in the house had not been previously injured, as would have been the case if they had developed from the egg stage inside the house, it seems probable that they were brought into the house in the larval stage with the soil. The fact that carnations growing in ordinary compost nearby were uninjured, indicates that the street sweepings contained the cut-worms when brought into the house.

The eggs are nearly hemispherical in shape and strongly ribbed, the ribs radiating from the center. They are laid in compact masses, containing about 60 eggs, often in rows, on the twigs or the under sides of the leaves of various plants. The larvæ are from one and one-half to one and three-fourths inches in length when full-grown. Up to this time they have molted five times, and in the full-grown stage of the larva there is great variation. A dark form is dull brown, more or less indistinctly marked with grey, with interrupted lines along the sides of the body. The cut-worms which attacked the carnations in the greenhouse were of the pale form, being of a dirty-grey color, with very faint markings. Plate VII shows this pale form about natural size, in both the extended position in which they feed, and in the resting position in which they spend the day coiled up beneath the surface of the ground.

The next stage is simply a naked brown pupa, found in the soil, yellow in color when first formed, and gradually changing to a dark mahogany-brown.

The adult is a moth of a brownish-grey color, having a wing-expanse of from one and three-fourths to two inches. There is great individual variation in the markings of the fore-wings. The hind-wings have no characteristic markings. They are usually white or light-grey near the body, shading into brown near the margins, and edged with a white fringe.

There are two broods each year, but the second is usually not extensive and does little damage. The winter is passed usually in the larval, but sometimes in the pupal stage, and, since much variation exists regarding the time of appearance and length of the breeding period, it is difficult to separate the two generations.

This is one of several species known as climbing cut-worms, which sometimes devour the foliage and injure the young fruit of apple, pear, peach, plum, cherry, and other trees. It is known to feed upon nearly all kinds of cultivated plants, both under glass and out of doors, and was reported as injuring carnations near New York City in 1894, Chicago in 1895, and at New London, Conn., in 1898;* in or near Philadelphia in 1890,† and in 1892.‡ Sirrine included this species in an article on insects infesting carnations, published in the *American Florist*, March 3, 1900.§ Dr. Felt had previously recorded an attack on carnations by the variegated cut-worm in a paper printed in *Country Gentleman*, May 11th, 1899.||

It caused much destruction in fields and gardens in the northwestern states during 1901, by devouring the foliage of all plants. Its attack resembled that of the army worm, and it was so abundant in the infested region that a square yard of ground contained hundreds of caterpillars. In serious outbreaks various mechanical measures, like ditching or rolling the land, may be put in practice to destroy the cut-worms. Paris green or arsenate of lead may be applied to the vegetation in their path, and thus great numbers may be killed.

In gardens and tilled fields cut-worms may be combated by placing poisoned bait on the ground short distances apart, a few days before the young plants appear. The bait may consist of fresh clover, or other succulent plants, which have been sprayed with Paris green, or of a bran mash to which poison and a little sugar have been added. If this method is practiced for a week or so before the crop occupies the ground, most of the cut-worms will be destroyed. Hand-picking at night will probably remain the most desirable remedy in greenhouses, as it is not advisable to poison the flowers, leaves or buds of plants which go to market. A thorough search during the day will disclose many of the worms coiled up beneath the surface

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* Bulletin 29, New Series, Division of Entomology, U. S. Dept. of Agriculture, 1901.

† Insect Life, Vol. II, p. 376.

‡ Idem, Vol. IV, p. 405.

§ Experiment Station Record, Vol. XI, p. 1065.

|| Fifteenth Report N. Y. State Entomologist, p. 594, 1899.

of the ground near the infested plants. It is possible that the poisoned bran mash would be effective even in greenhouses.

In connection with the variegated cut-worm was found another and smaller species that devoured the petals of the blossoms. Only two or three specimens were captured and the identity of the insect was not established.

A report was sent to the station in November, 1901, that chrysanthemums in the extensive greenhouses of a commercial grower were being injured by climbing cut-worms. Though no specimens were seen by the writer, the injury was probably caused by the variegated cut-worm. The remedy that was being practiced was hand-picking at night, though the owner writes that he has often trapped the caterpillars by placing damp tobacco stems on the bench or ground among the infested plants. The cut-worms crawl into the tobacco stems to rest during the day and may be shaken out in the morning and destroyed.

The following publications which have appeared in recent years contain good accounts of the variegated cut-worm.

Bulletin 29, New Series, Division of Entomology, U. S. Dept. of Agriculture, Washington, D. C., 1901; Bulletin 104, Cornell Experiment Station, Ithaca, N. Y., 1895; Bulletin 47, Washington Experiment Station, Pullman, Wash., 1901. The Fifth Report of the New York State Entomologist, page 200 (Albany, N. Y., 1888), has also a short account of the species, with bibliography up to that date.

Plate VII shows the variegated cut-worm in the larval and adult stages, and also some carnation buds injured by the larvæ.

ABUNDANCE OF THE ELM LEAF-BEETLE.

Galerucella luteola Müll.

The ravages of the elm leaf-beetle were especially serious in portions of the State during 1901. According to the daily papers, much injury was done to the trees in Hartford, Norwich, and other places. In New Haven the attack was probably more serious than it has been since 1896, when many trees were sprayed in the central portion of the city. In South Norwalk, where the beetle did much damage a few years ago, the trees were scarcely injured at all the past season.

The larvæ came down the trees in great numbers to transform about the middle of July. As the destruction of the pupæ tend to decrease the number of beetles for the next season, this was advised in the following press bulletin, issued July 15th, and printed in nearly all of the papers of the state:

NEW HAVEN, CONN., July 15, 1901.

In many Connecticut towns and cities, and especially in New Haven, the elm leaf-beetle has this season caused much injury to elm trees that might have been prevented by spraying poison on the foliage early in May to kill the adult beetles. Failing to do this, another spraying about the first of June would have prevented injury from the caterpillars. It is now too late to apply poison, as the injury has been done and the caterpillars are crawling down the trees in great numbers seeking a sheltered place in which to transform. All do not come down the trunk, however, as many drop from the branches to the ground, while some lodge in crevices of the rough bark of the trunk and larger branches, and there undergo their change to the pupa stage. But a large proportion may be found on the ground at the base of the tree, where they may be collected by the quart in some cases. It is an easy matter to destroy these pupæ, and it should be done at once, thus greatly diminishing the crop of egg-laying beetles for next year.

Where the city authorities are not prepared to act, citizens and residents should do so, each looking after the trees on and in front of his own property or residence.

To kill the insects, spray the ground under the tree and the trunk and lower branches if possible, with a soap or mechanical emulsion of kerosene and water, containing 10 per cent. of kerosene. This will kill all pupæ with which it comes in contact, and will not injure the trees or grass. Whale oil and common soaps are also effective if dissolved in water (one pound in five gallons) and applied as a spray. If a pump is not available, the soap solution may be sprinkled on the insects with a watering pot. By prompt and thorough concerted action on the part of both public officials and residents, much can be done in this way to prevent injury to the elm trees next season.

W. E. BRITTON, *State Entomologist.*

Before the publication of the above notice the writer had been asked to visit Norwich and look into the condition of the trees. The trip was made on July 16th, and the trees were found to be in a serious condition. The writer was taken through the principal streets by Mayor Thayer and Mr. W. F. Blackstone, two gentlemen much interested in the welfare of the trees.

A defective gas main had been laid, and afterwards replaced, for a distance of about one and one-half miles of the chief residential street of the city, and along this street many trees had died.

That the escaping gas killed many trees, there can be no doubt. Many fine elms on Broadway were dead and many others had lost their foliage, though the wood seemed to be still alive. Nearly all the elms appeared to be unthrifty. The maples, on the other hand (the street contains both elms and maples), were fairly thrifty, and the fact that these were not killed by gas led the writer to conclude that the elm leaf-beetle was to a considerable extent responsible for the damage. It is well known that illuminating gas escaping from pipes beneath the surface of the ground will kill any kind of a tree, and it has not been observed that the maple is less susceptible to its effect than other trees.

After a thorough inspection of the trees in Norwich, the writer was asked to make an additional statement for publication that would apply more particularly to local conditions. The following, therefore, was given out and appeared in the Norwich evening papers:

A personal examination of the elm trees along some of the principal resident streets of Norwich shows that the elm beetle has caused a great deal of damage this season. The caterpillars are now coming down the trees in large numbers, and should be destroyed immediately. A week or ten days from now the adult beetles will come forth and fly away. Hence immediate action is necessary. Spraying the trunks and larger branches of the trees, and also the ground under the trees, with kerosene, using either the soap emulsion or the mechanical mixture, each containing 10 per cent. of kerosene, is the best means of killing the beetles in this stage.

Kerosene emulsion may be prepared with soap as follows: Take one-half pound common hard soap and dissolve in boiling water. While this is still hot, add one gallon of kerosene and stir violently or churn it

through a force pump for about five minutes, until the whole forms a creamy mass, which thickens upon cooling. For use, dilute nine times with cold water.

The mechanical mixture is made by using a special form of pump, which mixes the two liquids under pressure. The trees along Broadway have unquestionably been injured by gas escaping from the main. They have also suffered great injury from the beetles, and the combined effect of gas and beetles has killed some of the trees. All residents should coöperate with the city authorities to kill as many of the beetles as possible right away.

It is hoped that the municipal authorities of Connecticut will be on the alert the coming season, and in readiness to spray the elm trees with poison if the beetles should be dangerously abundant, and thus prolong the lives of the trees, which, with their various other troubles, already have a precarious existence.

A SERIOUS INJURY TO HICKORY TREES BY THE HICKORY BARK BORER.

Scolytus quadrispinosus Say.

On August 1st, in answer to a request, the writer visited "Sachem's Wood," New Haven, to examine the hickory trees, which were in an unsatisfactory condition.

Many trees had died, and many more were fast losing their vitality. The foliage was falling from the supposedly healthy trees and the ground was literally covered with fresh and dried leaves. The many dead leaves still on the trees gave them a brown and scorched appearance. An examination of the twigs revealed great numbers of small black beetles, nearly one-fourth of an inch in length, which were boring holes in the axils of the compound leaves (see fig. 2), cutting them off in many cases so that they fell to the ground. In some instances the twig was eaten to such an extent that it broke off (see Plate VIII, b). The trunks of the dead and dying trees were the breeding grounds of the beetles, and larvæ, pupæ, and adults were numerous under the bark. The adults were emerging from the bark through small circular holes, which were so abundant that the tree appeared to have been filled with shot.

Specimens were sent to Washington for identification, and the beetle found to be *Scolytus quadrispinosus* Say. The late Dr. C. V. Riley studied this insect in Missouri in 1872, and

believing it to be a new species, described it as *S. caryæ.** Later it was found to be identical with Say's *quadrispinosus.*

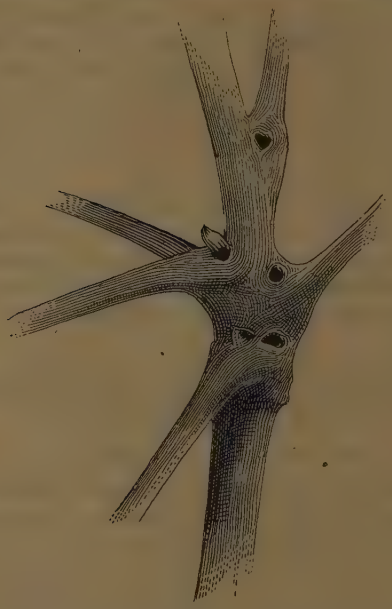


Fig. 2.—Hickory twig, showing where the beetles have made tunnels in the axils of the compound leaves. *Drawing made from an original photograph.*

The following account of the method of attack is copied from Dr. Riley's report:

"Boring through the bark, the insect forms a vertical chamber next to the wood, from half an inch to an inch in length, on each side of which it deposits its eggs, varying in number from twenty to forty or fifty in all. The larvæ, when hatched, feed on the inner bark, each one following a separate track, which is marked distinctly on the wood. Some trees contain them in such numbers that the bark is almost entirely separated from the wood. In many cases the upper part of the tree is killed a year or two before the lower part is attacked. . . . Both sexes bore into the tree—the male for food, and the female mostly for the purpose of laying her eggs. In thus entering the tree, they bore slantingly and upward, and do not confine themselves to the trunk,

* Fifth Annual Report, State Entomologist of Missouri, p. 103, 1873.

but penetrate the small branches and even the twigs. The entrance to the twig is usually made at the axil of a bud or leaf, and the channel often causes the leaf to wither and drop, or the twig to die or break off."

Packard* considers this the most destructive bark borer attacking the hickory.

Both sexes are dark brown or nearly black, the thorax darker than the wing-covers. There are numerous hairs upon the head, forming a brush which may perhaps be useful in cleaning out the galleries. This brush is more strongly developed in the male than in the female and is well shown in the left hand figure of the beetle on Plate VIII, a. Thorax and wing-covers are about equal in length, and the abdomen, which is shorter than the wing-covers, is truncated in a peculiar manner. The abdomen and thorax are more or less hairy on the ventral surface in both sexes, and some specimens have dorsal hairs on the front portion of the thorax and at the posterior extremity of the wing-covers.

On the end of the truncated abdomen, in the male there are four spines, which fact evidently suggested the specific name. The female, however, is not provided with these spines and the ventral portion of the abdomen is smooth. The beetles vary considerably in size in both sexes. Those examined by the writer were somewhat larger than the specimens studied by Riley and described as *S. caryæ* in the Fifth Report of the State Entomologist of Missouri, page 107. Riley gives the length as from .15 to .20 inch, while the specimens which the writer observed varied from .20 to .25 inch.

The brood gallery, which is formed between the bark and the wood, consists of a short vertical tunnel from which branch at right angles from twelve to seventeen smaller galleries on either side. These side tunnels are excavated by the young, each making a separate burrow, and though often very near each other never seem to cross, and are nearly parallel on each side of the central chamber. As the larvæ increase in size the tunnels diverge somewhat so as not to run into each other.

Miss Hillhouse states that 110 dead and dying trees were marked and cut, and that later several more were removed from the grove. From what we know of the habits of the *Scolytidae,*

* Fifth Report, U. S. Entomological Commission, p. 285, 1890.

it hardly seems probable that the beetles attacked perfectly sound trees in the beginning. But wherever a tree is injured by accident or weakened by any cause, an excellent breeding-place for the beetles is formed. In the summer of 1900, the drought was extremely severe in the vicinity of New Haven, and many trees suffered. The writer observed several hickories in the city parks that lost some of the branches or the entire top. The hickory trees on the Hillhouse place are in part situated on a dry knoll and it seems probable that some of these were injured by the drought. These injured trees were attacked by the beetles, which multiplied to such an extent that the adults in search of food attacked the twigs and branches of the more vigorous trees, thus weakening them sufficiently to enable the species to breed in the trunks. Finally a large number of good trees perished.

It was recommended that as many of the insects as possible be destroyed in the wood and bark of the trunk and that the remaining trees be kept in the best possible state of vigor by fertilizing, removing dead wood, etc. It is doubtful whether anything more than general preventive measures can be employed against these bark borers. Possibly in case of a severe attack upon thrifty trees it might be worth while to spray the foliage, twigs, and branches, as well as the bark of the trunk, with a thick whitewash to which Paris green had been added. Some of the beetles thus might be killed while feeding upon the twigs or when tunneling into the bark of the trunk to make the brood galleries.

SEVERE ATTACK OF THE FALL WEB-WORM.

Hyphantria cunea Drury.

The fall web-worm was very abundant during the season of 1901, and during August and September defoliated a great many trees including nearly all kinds of fruit, shade, and forest trees. The attack was not local, but extended all over the State and into Massachusetts and New York.

In September the writer observed defoliated trees in the forests along the Shepaug river valley, along the Air Line and Shore Line railroads, and through the central portion of the State. Along the Northampton railroad, many trees had lost

their leaves, and at New Canaan several hickory trees were bare the last of September. One of these is shown on Plate IX. Elms, birches, sycamores, and hickories were attacked at Simsbury and it seemed to make very little difference what the kind of tree.

The young caterpillars spin a web around two or three leaves and feed within the web, eating away the green portion of the leaf, the frame-work remaining. As the larvæ increase in size the entire branch is included in the web and the entire substance of the leaves is devoured, including veins. The fall web-worm is an American species and occurs all over the eastern part of the United States. It is not at all particular as to its food plants, and Howard states that the records of the Division of Entomology show about 120 species of forest, shade, ornamental and fruit trees upon which it feeds.* There are said to be two broods each year south of New York. The writer has not followed out the life-history of the species, but the observations made during 1901 indicate that it was also double-brooded in Connecticut.

It is an easy matter to remove the nests when small, from fruit trees, by cutting off the ends of the branches. Even this will be unnecessary if the foliage is kept well poisoned until late in the season.

COMMON SOAP AS AN INSECTICIDE.

It has long been known that soap-suds are useful in destroying plant lice, and the housewife as well as the gardener and florist has used them on plants with success. Our experience with soap as an insecticide began in the greenhouse by using "Ivory" soap, one-fourth pound dissolved in one gallon of water, and applied to chrysanthemums to kill black lice, to *Ageratum* to destroy *Aleyrodes* or white fly, to carnations to kill red spider, and to cinerarias, *Hibiscus* and cigar plant (*Cuphea*) to kill green lice. Whether the plants were dipped or whether the suds were applied as a spray, they destroyed the insects, but some of the plants were injured.

The mixture was then diluted one-half, and on January 12th all the carnation plants were sprayed to kill red spider, with satisfactory results. Wherever the spray came in contact with

* Farmers Bulletin, No. 99, p. 20, U. S. Department of Agriculture.

it, red spider was killed. But it is well nigh impossible to thoroughly cover thick-growing plants, so some lived to perpetuate the pest in the house. Later the plants were given a careful spraying once each week, and red spider was kept in check nicely even where it had thoroughly infested the plants. Lice and *Aleyrodes* were readily killed by the mixture, which is not only easily prepared but lacks the disagreeable odor peculiar to many insecticides, especially whale-oil soap and tobacco water.

As the soap does not dissolve readily in cold water, the best method is to cut the soap in thin slices and dissolve in boiling water, then add enough cold water to make the right proportions. The mixture thickens to a jelly-like substance on cooling and must therefore be applied warm. It may be sprayed upon the plants, or small potted plants may be dipped into a pailful of the mixture.

Bars of fresh "Ivory" soap were found to have an average weight, exclusive of the wrapper, of 258 grams, or about 9 ounces, while the small size weighed 152 grams, or 5.3 ounces. Thus in common practice, the soap need not be weighed nor the water measured, but half of a cake of laundry size or four-fifths of a small-sized cake will answer for a pailful. The common-sized pail holds two and one-half gallons when filled to the brim, but it cannot be conveniently carried if charged with more than two gallons.

"Welcome" soap was next given a trial and found to be fully as effective as "Ivory" when dissolved in the same proportions, and to dissolve somewhat more readily. It does not thicken as quickly on cooling. The bar of laundry-size weighs 317 grams, or about 11 ounces. One of these cakes may therefore be divided into three pieces and each dissolved in a pail of water.

The tomato house has each winter for several years been infested with white fly (*Aleyrodes vaporariorum* West.) and many remedies have been used, none of which have proved more effective than soap and water. Fir-tree oil was equally so, but is too expensive for general use. The tomato plants were sprayed about every week for three months with "Welcome" soap dissolved in water at the rate of one pound in 8 gallons. The spray seemed to kill all larvæ and adults with which it came in contact. During the operation many adults fly from the plants, but are hit by the spray when in mid-air and killed.

Continued applications of soap and water to the tomato plants for three months, without washing off the soap, finally coated the leaves to an injurious extent and the practice was abandoned. Other kinds of plants which were frequently sprayed with water from the hose were uninjured, and it is apparent that the long-continued use of the soap without washing it off is the reason for the injury. We still use this remedy for the same purpose, but either do not apply it so frequently or else the plants are sprayed occasionally with clear water.

Since then soap and water has been used here to kill *Aphis* on apple, plum, and cherry trees, and a great variety of plants, *Lecanium* on ferns, red spider, thrips, and newly-hatched scale-insects, especially oyster-shell and scurfy bark-louse, and San José scale. It is not effective in killing the mature individuals which are covered by the shell or armor, but readily kills the newly-hatched individuals.

Doubtless any laundry soap would answer the purpose quite as well as the kinds used, and for effectiveness, cheapness, convenience and cleanliness in preparing and using, soap and water should take a high rank among contact insecticides, especially for use in dwellings, greenhouses and gardens.

MISCELLANEOUS INSECT NOTES.

The Saddle-back Caterpillar—Empretia stimulea Clem.—was more abundant than usual and was observed in several localities. The caterpillar is dark-brown in color with a light green blanket or "saddle" upon its back, with a circular brown spot in the center. This spot is surrounded by a narrow ring of white. There is a light-green spot near the anterior end and three such spots near the posterior end of the body. There are two fleshy appendages covered with spines near each end, and a row of spiny tubercles along either side of the body. These spines are poisonous to the touch. This insect belongs to the family *Limacodidæ*, the larvæ of which have no legs and are called "slug-caterpillars." The adult is a brown moth. The caterpillars, which are usually not very abundant, feed upon the leaves of the apple, pear, and other fruit trees. Spraying with Paris green is the remedy.

The Hag-moth Caterpillar—Phobetron pithecium, S. & A.—is another of the "slug-caterpillars" and feeds upon the foliage

of apple and pear. This was also comparatively abundant the past season, as it is not usually a common insect here. In some respects this caterpillar is even more curious than the saddle-back caterpillar. Instead of being furnished with spines, there is a row of curious fleshy appendages along each side of the body and a double line of rosettes on the back, all brown in color. Lintner states* that there are four appendages on each side of the body, but I have found them very irregular in number, size and shape. But as the appendages are very easily detached, it is quite possible that some had been broken off. The adult is a yellowish-brown moth, having a wing-expanse of about one inch. The male is smaller than the female and varies slightly in color. This species is too rare to do much damage, but the foliage can be protected from it by coating the leaves with Paris green or some other arsenical poison.

The Red-humped Caterpillar—Œdemasia concinna S. & A.—feeds on the foliage of fruit trees, often defoliating them. The common name was suggested by the fact that the fourth segment of the body of the caterpillar forms a dorsal projection or hump and is of coral-red color. Plate X a, shows this caterpillar in its characteristic position with tail elevated. The body is striped with yellow, black, and white, and the segments bear spines.

In length, the caterpillars vary from one and one-fourth to one and one-half inches. The adult is a light-brown moth, having a wing-expanse of over an inch. There is only one brood each year. The arsenical poisons are a remedy where this caterpillar is abundant.

The Yellow-necked Caterpillar—Datana ministra Drury—was more abundant in Connecticut during 1901, than for several years. All kinds of fruit trees were defoliated and the species also attacked forest and shade trees. Young trees seem to be preferred by this insect. The larvæ are gregarious when young, and may often be seen in large clusters containing thirty or forty.

Except when feeding, the head and tail of each larva is elevated as shown in the illustration, Plate XI, b.

* Fifth Report, N. Y. State Entomologist, p. 184.

The caterpillars are about one and three-fourths inches long and striped with yellow and black. Their bodies are covered with long scattered hairs. The adult is a light-brown moth with dark-brown markings on the fore wings, and has a wing-spread of about two inches. There is one brood each year and the larvæ appear during August and September. On account of the gregarious habit of the caterpillars, it is an easy matter to cut off the twig upon which they are feeding, and this can be done while they are small and before much injury is done. They may then be crushed or burned. They may also be destroyed by applying kerosene to the soft-bodied caterpillars when clustered on the twigs. Fifteen per cent. of kerosene in water, applied with a "kerowater" pump, will not injure the foliage.

If the leaves have been sprayed with Paris green, they will not be injured by this insect.

The Walnut Caterpillar—Datana integerrima G. & R.—was more common than usual the past season. Black walnut, butternut, and hickory are the favorite food plants of the species, and the writer observed hickory trees attacked in New Haven, entirely defoliated in North Haven, and butternuts partially defoliated in Milford. Specimens were received from Morris Cove, East Haven, where the caterpillars were feeding upon the foliage of black walnut shade trees. The caterpillars are gregarious like the yellow-necked caterpillar when feeding upon the branches. When full grown they gather in large numbers upon the trunks of the trees.

The larvæ are from one to one and one-half inches long, body black, with long whitish hairs. Specimens were sent to Dr. H. G. Dyar of the United States National Museum at Washington, D. C., and he reported the species to be *D. integerrima.* It is often mistaken for *D. angusii,* but Dr. Dyar states that the latter is comparatively rare, while the former is the common one on walnut and hickory trees.

A small striped beetle—Chrysomela elegans Oliv.—attacked the leaves and flower stems of *Coreopsis lanceolata* growing in the writer's garden during the first week in June. Hand-picking was practiced every morning for about a week, and from a few plants a large number of beetles were gathered. These fed upon the leaves mostly, though the stems and petals

and calyx lobes of the blossoms were not unmolested. Among the beetles collected, there were a few specimens of *C. similis* Rog., feeding with *C. elegans,* but only one of the former to fifty of the latter.

Poisoning the foliage would of course preserve it, but hand-picking is the best remedy in a small flower garden.

The Orange Dog Caterpillar—Papilio cresphontes Cram.—was quite abundant during the season, and the caterpillar was found feeding upon the leaves of orange trees placed out of doors and of the gas plant, *Dictamnus fraxinella,* of gardens. It is a curious caterpillar of chocolate-brown and cream colors. The adult is a large black and yellow swallow-tail butterfly, closely allied to our celery butterfly, and is common in the Southern states. Only two specimens have been previously taken here during the past seven years. Connecticut is about the northern limit of the species.

The European giant hornet—Vespa crabro L.—was sent to the Station in September from Whitneyville, where it was reported as causing considerable injury to ripe pears by eating into them. Specimens were sent to Washington, and the identification verified. The species was brought into this country many years ago, and became established near New York City. It has since spread very slowly and even now is not found very far from the place where it was first discovered. It is occasionally seen in New Jersey and on Long Island. It was quite common on pears in the garden at the Station late in the season. It will probably not become sufficiently abundant to do much injury.

The green pea louse—Nectarophora pisi Kalt.—was considerably less abundant than in 1900 and 1899. In Connecticut it does not appear on peas until about June 1st, and the early varieties are then well along toward maturity and are not very seriously injured. The late varieties and the sweet peas are nearly ruined. Pea vines may be saved in the garden by spraying with kerosene emulsion or soap and water, but this is too expensive for the field, and there mechanical methods must be employed.

Brushing the vines and knocking off the lice just before cul-

tivating seems to be the most practicable of any means yet devised of holding this pest in check.

The pear psylla—Psylla pyricola Först.—caused less injury during the past season than for several years. Expecting another attack, we prepared for it by spraying all the pear trees at the Station on June 4, with kerosene and water (15 per cent. kerosene) mechanically mixed. The trees were not injured in the slightest, and unquestionably many of the insects were killed, though not present in dangerous numbers.

The tulip tree scale-insect—Lecanium tulipiferae Cook.—is becoming quite common on wild and cultivated tulip trees about the State. The females are nearly one-third of an inch in diameter when full-grown, are hemispherical in shape and of a dark-brown color. The males are much smaller, light-grey in color and more elongated. After the adult males emerge, the empty shells remain upon the twigs. There is only one brood each year. The species seems to be viviparous, and the young appear about September 1st. These live through the winter in a partially grown stage. The lower branches of the tulip tree are the ones first affected, and as these are killed, those higher up are attacked. Honey-dew is given off and in this substance grows a fungus which blackens the twigs and leaves. The magnolia is also a food plant of this species of *Lecanium*. A thorough spraying with soap and water, one pound dissolved in eight gallons, should free shade trees from this insect.

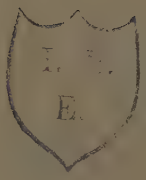
The snowy tree cricket—Œcanthus niveus Harr.—is very abundant throughout the State and causes slight injury to raspberry and blackberry canes by laying eggs in them. The canes often break off at the point where the eggs are deposited. Berry canes are not the only twigs selected by the insect for ovipositing, for the writer has found the eggs in grape-vine canes, and in the twigs of fruit trees. In some of the nurseries last fall they were common in peach branches, and apple twigs have frequently been chosen for the purpose. The adult insect feeds principally upon animal matter and therefore does not injure plants. There is no way to prevent the injury caused by egg-laying, but the twigs should be gathered in early spring and destroyed.

The maple borer—Plagionotus speciosus Say—is a serious enemy of maple trees in New Haven. On Prospect street especially, some young trees have been ruined and many severely injured. The adults emerge about the first of July, and for two weeks may be found on the trunks and larger branches of the trees, where they are laying eggs. The eggs soon hatch and the young larvæ begin to tunnel in the trees, usually eating partly in the bark and partly in the sap-wood, pursuing an upward spiral course. Sometimes two or more tunnels combine to girdle the tree. Shade trees should be examined during each September and the borers destroyed. Their presence is indicated by the castings or sawdust and the larvæ may be dug out, or killed by inserting a few drops of carbon bisulphide and stopping up the hole.

"Moth traps"—Manufacturers of certain kinds of "moth traps" have advertised extensively in the papers, claiming that orchards and gardens can be kept free from pests by the use of their devices for catching insects.

By these claims they have been able to sell many traps to orchardists and farmers. Several official entomologists, as well as other experimenters, have at different times and places made careful tests of "trap lanterns," "moth traps," etc., and the results of the trials disprove many of the manufacturer's claims. In some cases the traps caught more beneficial than injurious insects and therefore reputable entomologists have no hesitation in stating that more harm than good may be done by employing these "moth traps." Certainly such contrivances cannot be substituted for the ordinary spraying operations to fight insects in orchards.

Plum Tree killed by the San José Scale-Insect. *Photo. by W. E. Britton.*



Peach Tree severely injured by the San José Scale-Insect. *Photo. by W. E. Britton.*

I. B.
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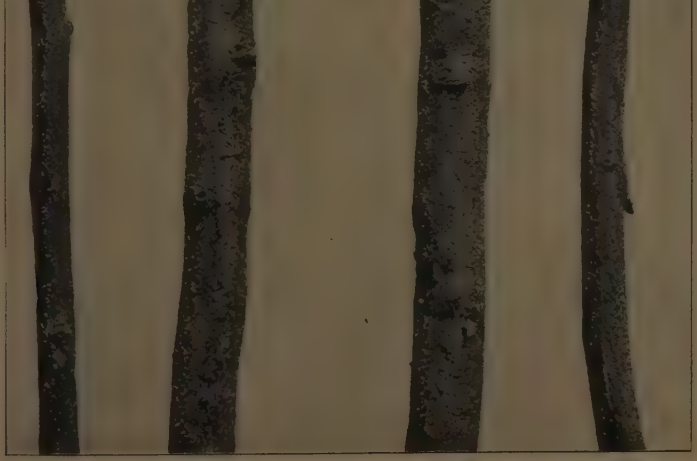
(*a*) Infested Peach Twigs. Mature females and young scales clustered in a groove of the twig may be seen at the left. A female with the shell or covering raised is shown at the right. Considerably enlarged. *Photo. by H. A. Doty.*



(*b*) Plum Twigs nearly coated over by San José Scale. Natural size. *Photo. by W. E. Britton.*

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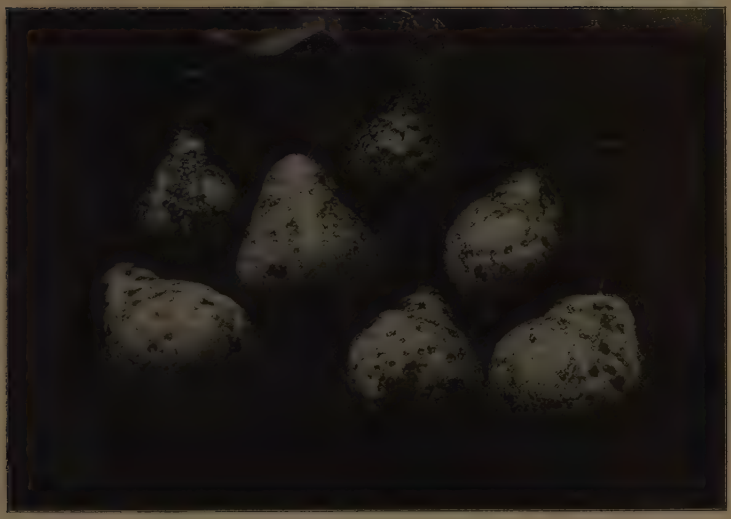

(*a*) Pears badly infested. *Photo. by H. A. Doty.*

(*b*) Infested Apples showing the discoloration around the Insects. *Photo. by H. A. Doty.*

Appearance of Infested Fruit.

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(*a*) Plums showing the reddish discoloration caused by the Insects. *Photo. by H. A. Doty.*

(*b*) Leaves, showing the tendency of the Insects to locate near the veins. *Photo. by H. A. Doty.*

Infested Leaves and Fruit of Japanese Plum.

I. B.
E.

PLATE VI

(*a*) Peach Tree sprayed April 12th, with a mechanical mixture of kerosene and water, containing 20 per cent. of kerosene. *Photo. in July by*

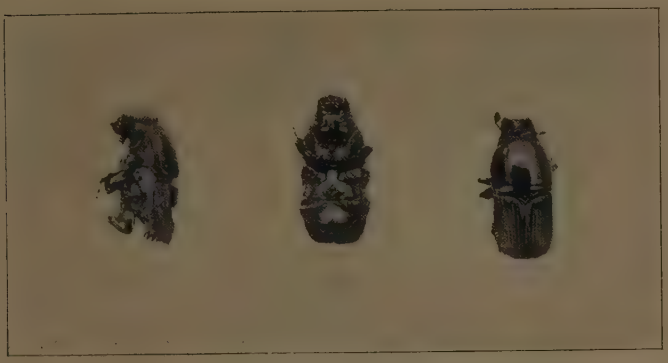
(*b*) Peach Tree sprayed April 12th with crude petroleum. *Photo. in July by W. E. Britton.*

(*a*) Buds injured by the cut-worm. *Photo. by W. E. Britton.*

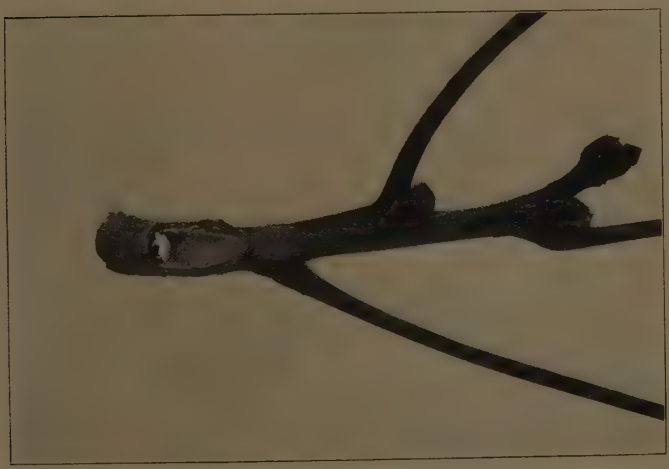
(*b*) Cut-worms or larvæ.
Photo. by W. E. Britton.

(*c*) Moths or Adults.
Photo. by H. A. Doty.

The Variegated Cut-Worm (Peridroma saucia) and its injury to Carnations—Figures all natural size.



(*a*) Adult Beetles. Considerably enlarged. *Photo. by H. A. Doty.*



(*b*) Hickory twig cut off by the beetles. Natural size. *Photo. by H. A. Doty.*

The Hickory Bark Borer (Scolytus quadrispinosus) and its work.

Hickory tree defoliated by the Fall Web-worm (*Hyphantria cunea*).
Photo. by Mr. Tuttle.

(*a*) The Red-humped Caterpillar (*Œdemasia concinna*) in characteristic feeding position. Natural size. *Photo. by H. A. Doty.*

(*b*) The Hag-moth Caterpillar (*Phobetron pithecium*). Slightly enlarged. *Photo. by H. A. Doty.*

(*a*) A Connecticut fumigating house. *Photo. by W. E. Britton.*

(*b*) The Yellow-necked Caterpillar (*Datana ministra*) in characteristic attitude. The caterpillar at the left is full-grown: those in the cluster are half-grown. Natural size. *Photo. by H. A. Doty.*

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